



# ***ELECTRICAL / PCC*** **Service Manual**



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# Electrical and Power Control Center Introduction

This section is designed to give a better understanding of the various panels or motor controls offered by OTTERBINE, as well as covering some of the basic electrical requirements needed in sizing and servicing various installations/applications.

In the **panel section**; a basic description, schematic diagram and parts list is referenced for each of the basic motor controls packages that have been the standard offering by OTTERBINE since 1985. This section serves more as a means by which to identify what type of panel you may be working on and how it is laid out. Trouble shooting of the panel is covered in the trouble shooting diagrams/flow charts depicted in the Concept<sub>2</sub> section.

In the **electrical section**; basic and/or required electrical formula's... (ie. consumption rate calculations, voltage drop calculations) installation accurately. 90% of all OTTERBINE service calls are due to improper installation. This section will help you in verifying that the proper electrical supply is available and the unit is installed and running correctly in accordance with the prescribed electrical spec.'s.

# Otterbine® Power Control Center

Otterbine Power Control Centers are available in the following:

115V Single Phase	208V-230V Three Phase
208V-230V Single Phase	460V Three Phase

- Ground Fault Interrupt Standard on all Single Phase Centers and on 208V/230V Three Phase Centers\*
- UL, ETL and ETL-C Safety Listed
- Components designed to meet or exceed IEC, UL, CSA, VDE, BS and other standards and listings
- Circuit Breaker Protection on all Single and 208/230V Three Phase
- Fuse Protection on 460V Three Phase
- Neutral Block for 115V Termination
- Surge/Lightning protection\*\*
- Manual External Reset
- NEMA 3R Rated Enclosure  
(NEMA 4 and 12 Enclosures Available)
- Non-Reversing Magnetic Starters with Twin Break Silver Cadmium Oxide Contacts
- Lockable Panel Disconnect to Lock Unit in Off Mode
- Dual Lockable Latches to Secure Enclosure
- Installed Hand/Off/Auto Switch
- 24 Hour On/Off Timer
- Enclosure Manufactured from .075 Thick Steel

**-Options: Multiple Starter in One Enclosure**  
**Phase Monitoring**  
**GFCI/EPD Devices 460V**  
**Step Down Transformers**  
**Remote Satellite Control**  
**50Hz Power Control Centers**  
**Stainless Steel Enclosure**  
**Water Level Shut Off**

\*GFCI/EPD is optional on 460V Centers.

\*\*While no surge arrestor can protect equipment from damage caused by a direct lightning hit, our unit can immediately drain lightning surges induced in the wiring safely to ground.



H (Height)...22" (56 cm)

W (Width)...16" (41 cm)

D (Depth)...7" (18 cm)



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03/6/00PCC

# Cutler Hammer Parts List

HP	Electrical Rating	Overload Relay P/N	Contactors P/N	Coil P/N	Circuit Breaker P/N	Fuse P/N	GFCI P/N
1	115V 1Ph 60 Hz	31-0133-018	31-0132-003	31-0027-120	31-0047	n/a	*
1	208-230V 1Ph 60Hz	31-0133-016	31-0132-001	31-0027-120	31-0047	n/a	*
2	208-230V 1Ph 60Hz	31-0133-018	31-0132-003**	31-0027-120	31-0047	n/a	*
3	208-230V 1Ph 60Hz	31-0133-018	31-0132-003	31-0027-120	31-0047	n/a	*
3	208-230V 3Ph 60Hz	31-0133-016	31-0132-002	31-0027-120	31-0128-330	n/a	31-0010
3	460V 3Ph 60Hz	31-0133-012	31-0132-001	31-0027-120	n/a	31-0009-007	n/a
5	230V 1Ph 60Hz	31-0133-019	31-0132-004	31-0027-120	31-0047-250	n/a	*
5	208-230V 3Ph 60Hz	31-0133-018	31-0132-003	31-0027-120	31-0128-330	n/a	31-0010
5	460V 3Ph 60Hz	31-0133-014	31-0132-001	31-0027-120	n/a	31-0009-012	n/a
5	575V 3Ph 60Hz	31-0133-014	31-0132-001	31-0027-120	n/a	31-0009-010	n/a
1	220V 1Ph 50Hz	31-0133-016	31-0132-005	31-0027-240	n/a	31-0009-010	n/a
2	220V 1Ph 50Hz	31-0133-018	31-0132-005	31-0027-240	n/a	31-0020-020	n/a
3	220V 1Ph 50Hz	31-0133-018	31-0132-005	31-0027-240	n/a	31-0020-020	n/a
3	380/415V 3Ph 50Hz	31-0133-012	31-0132-001	31-0027-120	n/a	31-0009-007	n/a
5	380/415V 3Ph 50Hz	31-0133-014	31-0132-001	31-0027-120	n/a	31-0009-012	n/a
10	208-230V 3Ph 60Hz	31-0141-002	31-0132-007	31-0054-120	31-0092-350	n/a	31-0010
10	460V 3Ph 60Hz	31-0133-017	31-0132-003	31-0027-120	n/a	31-0009-025	n/a
10	380/415V 3Ph 50Hz	31-0133-016	31-0132-003	31-0027-120	n/a	31-0009-015	n/a

\*GFCI part of Circuit Breaker

\*\*Changed from 31-0132-002 to 31-0132-003 per ECN #02-0304

Units Built prior to 1/1/2001 Contact OTTERBINE for correct part #'s

# SIEMENS/SQUARE D Parts List

	Contactor	Overload Relay	Circuit Breaker	Breaker Mtg Base	Disconnect
<b>Concept 3/Concept 2</b>					
1HP 115V 1Ph 60Hz	31-0147-003	31-0148-007	31-0049-125	31-0056-001	31-0160-040
1HP 230V 1Ph 60Hz	31-0147-003	31-0148-004	31-0049-230	31-0056-002	31-0160-040
2HP 230V 1Ph 60Hz	31-0147-003	31-0148-006	31-0049-230	31-0056-002	31-0160-040
3HP 230V 1Ph 60Hz	31-0147-003	31-0148-007	31-0049-230	31-0056-002	31-0160-040
3HP 230V 3Ph 60Hz	31-0147-003	31-0148-005	31-0055-330	31-0056-003	31-0160-040
3HP 460V 3Ph 60Hz	31-0147-003	31-0148-002	n/a	n/a	31-0160-040
5HP 230V 1Ph 60Hz	31-0147-004	31-0148-010	31-0049-250	31-0056-002	31-0160-060
5HP 230V 3Ph 60Hz	31-0147-003	31-0148-007	31-0055-330	31-0056-003	31-0160-040
5HP 460V 3Ph 60Hz	31-0147-003	31-0148-004	n/a	n/a	31-0160-040
5HP 575V 3Ph 60Hz	31-0147-003	31-0148-003	n/a	n/a	31-0160-040
1HP 220V 1Ph 50Hz	31-0147-005	31-0148-004	n/a	n/a	31-0160-040
2HP 220V 1Ph 50Hz	31-0147-005	31-0148-006	n/a	n/a	31-0160-040
3HP 220V 1Ph 50Hz	31-0147-005	31-0148-007	n/a	n/a	31-0160-040
3HP 380/415V 3Ph 50Hz	31-0147-003	31-0148-002	n/a	n/a	31-0160-040
5HP 380/415V 3Ph 50Hz	31-0147-003	31-0148-004	n/a	n/a	31-0160-040
<b>10HP Concept 1</b>					
10HP 230V 3Ph 60Hz	31-0147-006	31-0148-010	31-0055-350	31-0056-003	31-0160-060
10HP 460V 3Ph 60Hz	31-0147-003	31-0148-006	n/a	n/a	31-0160-040
10HP 380/415V 3Ph 60Hz	31-0147-003	31-0148-006	n/a	n/a	31-0160-040
<b>Giant Fountain</b>					
7.5HP 230V 1Ph 60Hz	n/a	n/a	31-0055-290	31-0056-002	31-0160-100
7.5HP 230V 3Ph 60Hz	31-0147-006	31-0148-010	31-0055-360	31-0056-003	31-0160-060
7.5HP 460V 3Ph 60Hz	31-0147-006	31-0148-008	31-0159-330	n/a	31-0160-040
10HP 230V 1Ph 60Hz	n/a	n/a	31-0055-290	31-0056-002	31-0160-100
10HP 230V 3Ph 60Hz	31-0147-007	31-0148-011	31-0055-370	31-0056-003	31-0160-080
10HP 460V 3Ph 60Hz	31-0147-006	31-0148-009	31-0159-330	n/a	31-0160-040
15HP 230V 1Ph 60Hz	n/a	n/a	31-0055-290	31-0056-002	31-0160-100
15HP 230V 3Ph 60Hz	31-0147-007	31-0148-012	31-0055-390	31-0056-003	31-0160-100
15HP 460V 3Ph 60Hz	31-0147-006	31-0148-010	31-0159-350	n/a	31-0160-060
25HP 230V 3Ph 60Hz	31-0147-008	31-0148-013	31-0055-3100	31-0056-003	31-0160-100
25HP 460V 3Ph 60Hz	31-0147-007	31-0148-011	31-0159-380	n/a	31-0160-080
7.5HP 380/415V 3Ph 50Hz	31-0147-006	31-0148-008	31-0159-330	n/a	31-0160-040
10HP 380/415V 3Ph 50Hz	31-0147-006	31-0148-009	31-0159-340	n/a	31-0160-040
15HP 380/415V 3Ph 50Hz	31-0147-006	31-0148-010	31-0159-350	n/a	31-0160-060
25HP 380/415V 3Ph 50Hz	31-0147-007	31-0148-012	31-0159-380	n/a	31-0160-080

# Contactor and Overload Relay Cross Reference Table 1

HP	Electrical Rating	Siemens Contactor P/N	Cutler-Hammer Contactor P/N	Siemens Overload Relay P/N	Cutler-Hammer Overload Relay P/N
C3/C2					
1	115V 1Ph 60Hz	31-0147-003	31-0132-003	31-0148-007	31-0133-018
1	208-230V 1Ph 60Hz	31-0147-003	31-0132-003	31-0148-004	31-0133-016
2	208-230V 1Ph 60Hz	31-0147-003	31-0132-003	31-0148-006	31-0133-018
3	208-230V 1Ph 60Hz	31-0147-003	31-0132-003	31-0148-007	31-0133-018
3	208-230V 3Ph 60Hz	31-0147-003	31-0132-002	31-0148-005	31-0133-016
3	460V 3Ph 60Hz	31-0147-003	31-0132-001	31-0148-002	31-0133-012
5	230V 1Ph 60Hz	31-0147-004**	31-0132-004	31-0148-010**	31-0133-019
5	208-230V 3Ph 60Hz	31-0147-003	31-0132-003	31-0148-007	31-0133-018
5	460V 3Ph 60Hz	31-0147-003	31-0132-001	31-0148-004	31-0133-014
5	575V 3Ph 60Hz	31-0147-003	31-0132-001	31-0148-003	31-0133-014
1	220V 1Ph 50Hz	31-0147-005	31-0132-005	31-0148-004	31-0133-016
2	220V 1Ph 50Hz	31-0147-005	31-0132-005	31-0148-006	31-0133-018
3	220V 1Ph 50Hz	31-0147-005	31-0132-005	31-0148-007	31-0133-018
3	380/415V 3Ph 50Hz	31-0147-003	31-0132-001	31-0148-002	31-0133-012
5	380/415V 3Ph 50Hz	31-0147-003	31-0132-001	31-0148-004	31-0133-014
C1					
10	208-230V 3Ph 60Hz	31-0147-006	31-0132-007	31-0148-010	31-0141-002
10	460V 3Ph 60Hz	31-0147-003	31-0132-003	31-0148-006	31-0133-017
10	380/415V 3Ph 50Hz	31-0147-003	31-0132-003	31-0148-006	31-0133-016
Giant Ftn					
7.5	230V 3Ph 60Hz	31-0147-006	31-0015-007	31-0148-010	31-0094-014
7.5	460V 3Ph 60Hz	31-0147-006	31-0015-007	31-0148-008	31-0094-011
10	230V 3Ph 60Hz	31-0147-007	31-0015-007	31-0148-011	31-0094-014
10	460V 3Ph 60Hz	31-0147-006	31-0015-007	31-0148-009	31-0094-012
15	230V 3Ph 60Hz	31-0147-007	31-0015-008	31-0148-012	31-0094-016
15	460V 3Ph 60Hz	31-0147-006	31-0015-007	31-0148-010	31-0094-012
25	230V 3Ph 60Hz	31-0147-008	31-0015-009	31-0148-013	31-0094-017
25	460V 3Ph 60Hz	31-0147-007	31-0015-008	31-0148-011	31-0094-015
7.5	380/415V 3Ph 50Hz	31-0147-006	31-0015-007	31-0148-008	31-0094-011
10	380/415V 3Ph 50Hz	31-0147-006	31-0015-007	31-0148-009	31-0094-012
15	380/415V 3Ph 50Hz	31-0147-006	31-0015-007	31-0148-010	31-0094-014
25	380/415V 3Ph 50Hz	31-0147-007	31-0015-008	31-0148-012	31-0094-016
Inst Ftn					
½	230V 1Ph 60Hz	31-0169-001	31-0036-001	n/a	n/a
¾	230V 1Ph 60Hz	31-0169-001	31-0036-001	n/a	n/a

**\* NOTE:** When replacing Cutler-Hammer components with Siemens components in the field both the contactor and the overload relay need to be replaced, and installation instructions (P/N 75-0088) need to be added to the order as a separate line item.

**\*\* The Siemens contactor and overload can not be used to replace Cutler-Hammer in small PCC's (16x12x6) due to size constraints.**

**\*\*\* Do not install a Siemens contactor in a Cutler-Hammer 460 V PCC which is not equipped with a stepdown transformer. (Direct 220 V control voltage will damage the Siemens contactor). An option to this solution would be to purchase a Siemens contactor which is rated for 220 V.**



## Circuit Breaker Cross Reference Table 2

HP	Electrical Rating	Square-D Breaker P/N	Square-D Mtg Base P/N	Cutler-Hammer Breaker P/N	Cutler-Hammer Mtg Base P/N
C3/C2					
1	115V 1Ph 60Hz	31-0049-125	31-0056-001	31-0047	31-0048
1	208-230V 1Ph 60Hz	31-0049-230	31-0056-002	31-0047	31-0048
2	208-230V 1Ph 60Hz	31-0049-230	31-0056-002	31-0047	31-0048
3	208-230V 1Ph 60Hz	31-0049-230	31-0056-002	31-0047	31-0048
3	208-230V 3Ph 60Hz	31-0055-330	31-0056-003	31-0128-330	31-0155
5	230V 1Ph 60Hz	31-0049-250	31-0056-002	31-0047-250	31-0048
5	208-230V 3Ph 60Hz	31-0055-330	31-0056-003	31-0128-330	31-0155
C1					
10	208-230V 3Ph 60Hz	31-0055-350	31-0056-003	31-0092-350	31-0048
Giant Ftn					
7.5	230V 1Ph 60Hz	31-0055-290	31-0056-002	31-0092-290	31-0048
7.5	230V 3Ph 60Hz	31-0055-360	31-0056-003	31-0092-360	31-0048
7.5	460V 3Ph 60Hz	31-0159-330	n/a	31-0093-330	n/a
10	230V 1Ph 60Hz	31-0055-290	31-0056-002	31-0092-290	31-0048
10	230V 3Ph 60Hz	31-0055-370	31-0056-003	31-0092-370	31-0048
10	460V 3Ph 60Hz	31-0159-330	n/a	31-0093-330	n/a
15	230V 1Ph 60Hz	31-0055-290	31-0056-002	31-0092-290	31-0048
15	230V 3Ph 60Hz	31-0055-390	31-0056-003	31-0092-390	31-0048
15	460V 3Ph 60Hz	31-0159-350	n/a	31-0093-350	n/a
25	230V 3Ph 60Hz	31-0055-3100	31-0056-003	31-0092-3100	31-0048
25	460V 3Ph 60Hz	31-0159-380	n/a	31-0093-380	n/a
7.5	380/415V 3Ph 50Hz	31-0159-330	n/a	31-0093-330	n/a
10	380/415V 3Ph 50Hz	31-0159-340	n/a	31-0093-340	n/a
15	380/415V 3Ph 50Hz	31-0159-350	n/a	31-0093-350	n/a
25	380/415V 3Ph 50Hz	31-0159-380	n/a	31-0093-380	n/a

**\* NOTE:** When replacing Cutler-Hammer circuit breakers with Square-D circuit breakers in the field both the circuit breaker and the mounting base need to be replaced, and installation instructions (P/N 75-0089) need to be added to the order as a separate line item.

# Siemens Overload Relay Settings

HP	Electrical Rating	Contactor P/N	Overload Relay P/N	Concept <sub>3</sub> Overload Relay Setting *		Concept <sub>2</sub> Overload Relay Setting *	
				Standard	MAX	Standard	MAX
1	115V 1Ph 60Hz	31-0147-003	31-0148-007	15.0	16.0	14.0	14.6
1	208-230V 1Ph 60Hz	31-0147-003	31-0148-004	8.0	8.8	7.0	7.5
2	208-230V 1Ph 60Hz	31-0147-003	31-0148-006	13.3	15.0	12.0	13.0
3	208-230V 1Ph 60Hz	31-0147-003	31-0148-007	16.3	18.7	14.0	15.0
3	208-230V 3Ph 60Hz	31-0147-003	31-0148-005	9.6	10.8	9.0	9.6
3	460V 3Ph 60Hz	31-0147-003	31-0148-002	4.3	4.8	4.0	4.6
5	230V 1Ph 60Hz	31-0147-004	31-0148-010	23.0	23.0**		
5	208-230V 3Ph 60Hz	31-0147-003	31-0148-007	15.2	17.2	14.0	15.5
5	460V 3Ph 60Hz	31-0147-003	31-0148-004	7.5	8.0	7.0	8.1
5	575V 3Ph 60Hz	31-0147-003	31-0148-003	6.0	6.5	6.0	6.4
1	220V 1Ph 50Hz	31-0147-005	31-0148-004	8.2	9.0	7.0	7.5
2	220V 1Ph 50Hz	31-0147-005	31-0148-006	13.0	14.0	12.0	13.0
3	220V 1Ph 50Hz	31-0147-005	31-0148-007	14.0	15.7	14.0	15.0
3	380/415V 3Ph 50Hz	31-0147-003 or 31-0147-005***	31-0148-002	4.3	4.8	4.0	4.6
5	380/415V 3Ph 50Hz	31-0147-003 or 31-0147-005***	31-0148-004	7.0	7.6	7.0	7.6
10	208-230V 3Ph 60Hz	31-0147-006	31-0148-010			26.0	27.5
10	460V 3Ph 60Hz	31-0147-003	31-0148-006			12.8	14.7
10	380/415V 3Ph 50Hz	31-0147-003	31-0148-006			11.0	12.6

\* Overload Relays should initially be set at standard setting. Only if tripping occurs with amps in all lines measured to be within nameplate maximum amps should the setting be increased, not to exceed the MAX setting shown.

**NOTICE:** WARRANTY IS VOID if the thermal overload is set above the MAX setting.

\*\* The 5HP 1Ph Motor has a 1.0 service factor, therefore, the standard and the max settings are the same.

\*\*\* Contactor with 240V coil (p/n 31-0147-005) used as of December 2005

## Siemens Overload Relay Specifications

Overload Relay P/N	Siemens P/N	Amperage Range
31-0148-002	3RU1126-1FB0	3.5A – 5A
31-0148-003	3RU1126-1HB0	5.5A – 8A
31-0148-004	3RU1126-1JB0	7A – 10A
31-0148-005	3RU1126-1KB0	9A – 12.5A
31-0148-006	3RU1126-4AB0	11A – 16A
31-0148-007	3RU1126-4BB0	14A – 20A
31-0148-008	3RU1136-4AB0	11A – 16A
31-0148-009	3RU1136-4BB0	14A – 20A
31-0148-010	3RU1136-4EB0	22A – 32A

## Siemens Overload Relay Settings - GF

HP	Electrical Rating	Contactor P/N	Overload Relay P/N	Overload Relay Setting *	
				Standard	MAX
7.5	230V 1Ph 60Hz	n/a	n/a	n/a	n/a
7.5	230V 3Ph 60Hz	31-0147-006	31-0148-010	22.9A	24.6A
7.5	460V 3Ph 60Hz	31-0147-006	31-0148-008	11.4A	12.3A
7.5	380/415V 3Ph 50Hz	31-0147-006 or 31-0147-009**	31-0148-008	13.0A	13.0A
10	230V 1Ph 60Hz	n/a	n/a	n/a	n/a
10	230V 3Ph 60Hz	31-0147-007	31-0148-011	29.9A	32.2A
10	460V 3Ph 60Hz	31-0147-006	31-0148-009	15.0A	16.1A
10	380/415V 3Ph 50Hz	31-0147-006 or 31-0147-009**	31-0148-009	16.3A	16.3A
15	230V 1Ph 60Hz	n/a	n/a	n/a	n/a
15	230V 3Ph 60Hz	31-0147-007	31-0148-012	44.1A	47.4A
15	460V 3Ph 60Hz	31-0147-006	31-0148-010	22.0A	23.7A
15	380/415V 3Ph 50Hz	31-0147-006 or 31-0147-009**	31-0148-010	24.0A	24.0A
25	230V 3Ph 60Hz	31-0147-008	31-0148-013	69.8A	75.0A
25	460V 3Ph 60Hz	31-0147-007	31-0148-011	34.9A	37.5A
25	380/415V 3Ph 50Hz	31-0147-007 or 31-0147-010**	31-0148-012	40.0A	40.0A

\* Thermal Overloads should initially be set at standard setting (Pre-set at factory). Only if tripping occurs with amps in all lines measured to be within nameplate maximum amps should the setting be increased, not to exceed the MAX setting shown.

**NOTICE:** WARRANTY IS VOID if the thermal overload is set above the MAX setting.

\*\* Contactor with 240V coil (p/n 31-0147-009 & 31-0147-010) used as of December 2005

### Siemens Overload Relay Specifications

Overload Relay P/N	Siemens P/N	Amperage Range
31-0148-008	3RU1136-4AB0	11A – 16A
31-0148-009	3RU1136-4BB0	14A – 20A
31-0148-010	3RU1136-4EB0	22A – 32A
31-0148-011	3RU1136-4FB0	28A – 40A
31-0148-012	3RU1136-4HB0	40A – 50A
31-0148-013	3RU1146-4KB0	57A – 75A

# Maximum Cable Lengths Based on a 5% Maximum Voltage Drop

CAUTION: These cable lengths are based on assuming the voltage in the control panel is at the nominal voltage listed. If the voltage is less than nominal with the aerator and other loads energized, the voltage drop will be greater. This will cause the aerator to require more current, produce less torque, run hotter, and may cause motor failure. If the distance from the power source to the aerator's location is longer than the distance listed, contact your distributor or the Otterbine factory for a solution.

HP Rating	Voltage Phase & Hz	Avg. Running Amperage	Wire Size #10	Wire Size #12
1/6	115 1 ph. 60Hz.	1.8	n/a	*600
1/6	208 1 ph. 60Hz	1.1	n/a	*600
1/6	230 1 ph. 60Hz	1.0	n/a	*600
1/6	220 1 ph. 50Hz	1.0	n/a	*600
1/2	115 1 ph. 60Hz	12.0	n/a	*125
1/2	230 1 ph. 60Hz	6.0	n/a	*480
1/2	220 1 ph. 50Hz	3.9	n/a	*700
3/4	230 1 ph. 60Hz	8.0	n/a	*350
1	115 1 ph. 60Hz	13.4	175	110
1	208 1 ph. 60Hz	7.4	565	355
1	230 1 ph. 60Hz	6.7	690	430
1	220 1 ph. 50Hz	7.7	550	350
2	208 1 ph. 60Hz	12.9	325	200
2	230 1 ph. 60Hz	11.7	395	250
2	220 1 ph. 50Hz	12.4	360	225
3	208 1 ph. 60Hz	14.1	295	n/a
3	230 1 ph. 60Hz	12.8	360	n/a
3	220 1 ph. 50Hz	14.9	300	n/a
3	208 3 ph. 60Hz	9.4	515	320
3	230 3 ph. 60Hz	8.5	630	395
3	460 3 ph. 60Hz	4.3	2,500	1,500
3	380 3 ph. 50Hz	4.6	1,925	1,200
5	208 3 ph. 60Hz	15.4	310	195
5	230 3 ph. 60Hz	14.0	380	240
5	460 3 ph. 60Hz	8.0	1,500	950
5	380 3 ph. 50Hz	6.5	1,350	850
10	208 3 ph. 60Hz	26.4	180	n/a
10	230 3 ph. 60Hz	24.0	225	n/a
10	460 3 ph. 60Hz	12.0	850	n/a
10	380 3 ph. 50Hz	15.5	575	n/a

\*Note: The above cable lengths are determined using the method per the 1993 National Electrical Code Handbook, Article 215-2. In some cases, the values listed are the maximum cable lengths available for the particular model and/or set by other restrictions. Contact the Otterbine factory, if your application is not within these guidelines.

\*\*Note: Amperage may vary depending on model and age of the unit.

## How To Calculate Voltage Drop

Per the 1999 national Electrical Code Article 215-2 and 210-19, the following basic formulas can be used to calculate voltage drop. Please note the different formula for 1 phase and 3 phase.

**NOTE:** Voltage drop **must** be under **5% maximum** from **service entrance to aerator!!!**

$$\text{Voltage Drop (1 phase)} = \frac{2 \times \text{FEET} \times \text{AMPS} \times R}{1000}$$

$$\text{Voltage Drop (3 phase)} = \frac{1.732 \times \text{FEET} \times \text{AMPS} \times R}{1000}$$

AMPS	=	Amperage/current of the unit
2	=	Multiplier for single phase only
1.732	=	Multiplier for three phase only
FEET	=	One way length of power cable
R	=	Resistance value for the gauge wire used per table below

### Resistance Values (R) -Copper Wire Only

Wire Size (A.W.G.)	R	Wire Size (Metric Wire Gauge)	R
16	5.0	20	2.100
14	3.1	25	1.870
12	2.0	30	.948
10	1.2	35	.694
8	.78	40	.536
6	.49	45	.421
4	.3	50	.340
2	.201	60	.236
0	.13	70	.172

### EXAMPLES:

A 2 HP, 230 volt, 1 phase, 11.7 amp aerator has a 12 AWG cord of 200 feet.  
What is the voltage drop?

$$\text{AMPS} = 11.7 \quad R = 2.0 \quad \text{FEET} = 200$$

$$\text{VD(1 phase)} = \frac{2 \times 200 \times 11.7 \times 2.0}{1000} = 9.36 \text{ volts}$$

For proper installation, the voltage drop must not exceed 5%. Five percent of 230 volts is 11.5 volts. 9.36 volts is less than 11.5 indicating the drop is within specification (4.1%).

### EXAMPLES :

A new installation of a 5hp, 230 volt 3 phase, 14.0 amp aerator is being considered. The actual voltage at the main power panel at the site is 230 volts with all other loads on. The aerator's power panel will be located 200 feet from the main panel and the aerator's cable must be 100 feet in order to place it at the proper location.

### Can 12 AWG wire be used ?

Total length is  $200 + 100 = 300$  feet.

AMPS = 14.0

Voltage Drop must not exceed 5% or  $(230 \times .05) = 11.5$  volts

$$VD(3 \text{ phase}) = \frac{1.732 \times 300 \times 14.0 \times 2.0}{1000} = 14.5 \text{ volts}$$

14.5 is 6.3 % of 230 volts exceeding the 5%. This gauge can not be used.

### Can 10 AWG be used ?

$$VD(3 \text{ phase}) = \frac{1.732 \times 300 \times 14.0 \times 1.2}{1000} = 8.7 \text{ volts}$$

8.7 is only 3.8% of 230, 10 AWG can be used.

### Can 10 AWG be used to connect the aerator's panel to the main with a 12 AWG aerator cable?

This requires two calculations, one for the 10 AWG cable length and another for the 12 AWG cable.

A) The 10 AWG cable,  $VD(3 \text{ phase}) = \frac{1.732 \times 200 \times 14.0 \times 1.2}{1000} = 5.82 \text{ volts}$

B) The 12 AWG cable,  $VD(3 \text{ phase}) = \frac{1.732 \times 100 \times 14.0 \times 2.0}{1000} = 4.85 \text{ volts}$

Total voltage drop is  $5.82 + 4.85 = 10.67$  volts or 4.6% of 230 volts. This configuration would meet specification.

### Calculating Horsepower / Kilowatt Ratings: (International Power Ratings)

$$HP \times .746 = KW$$

### Calculating Load Kilowatts (Electric Costs)

The formulas for calculating Kilowatts are:

$$KW(1 \text{ ph}) = \frac{I \times E \times PF}{1000} \quad KW(3 \text{ ph}) = \frac{I \times E \times 1.73 \times PF}{1000}$$

where KW(1 ph) = Kilowatts for single phase only

I = Amperage

E = Voltage

PF = Power Factor of the Motor from table below

### Power Factors of Franklin Motors:

1/6HP	= .94	1/2HP	= .58	10HP415v(3ph)	= .81
1/3HP	= .94	3/4HP	= .62	15HP(1ph)	= .98
1HP	= .74	7.5HP(1ph)	= .90	15HP230&460v(3ph)	= .83
2HP	= .76	7.5HP,230&460v(3ph)	= .81	15HP,380v(3ph)	= .87
3HP(1 ph)	= .85	7.5HP,380v(3ph)	= .85	15HP,415v(3ph)	= .81
3HP(3 ph)	= .87	10HP(1ph)	= .96	25HP,230&460v(3ph)	= .85
5HP(3 ph)	= .84	10HP,230&460v(3ph)	= .83	25HP,380v(3ph)	= .87
PC-12 10HP(3 ph)	= .91	10HP380v(3ph)	= .87	25HP415v(3ph)	= .83

**Examples:**

A 2 HP (1 ph) unit operating at 230 Volts has an amperage draw of 11.7 amps.  
What is the Kilowatt rating?

$$KW(1 \text{ ph}) = \frac{11.7 \times 230 \times .76}{1000} = 2.05 \text{ kilowatts}$$

A 5 HP(3 ph) unit operates at 460 volts and has an amperage draw of 8.0 amps.  
What is the kilowatt rating?

$$KW(3 \text{ ph}) = \frac{8.0 \times 460 \times 1.73 \times .84}{1000} = 5.35 \text{ kilowatts}$$

**Calculating Electrical Operating Costs**

To calculate electrical operating costs per hour use the following:

$$COST = KW \times (\text{cost of one KWHR})$$

where KW is the kilowatt rating from above and (cost of one KWHR) is the cost of using one kilowatt of power in one hour (obtained from power company).

**Example:**

a 2 HP unit has a kilowatt rating of 2.05KW. Power cost is \$.05/KwHr.

Cost =  $2.05 \times .05 = .10$  / hour ; if ran for 10 hours/day, cost would be \$1.00/day.

**Calculating KVA (For sizing transformers)**

The formulas for calculating Kva are:

$$Kva(1 \text{ ph}) = \frac{I \times E}{1000} \qquad Kva(3 \text{ ph}) = \frac{I \times E \times 1.73}{1000}$$

where Kva(1 ph) = Kva for single phase only

$$\begin{array}{lll} I & = & \text{Amperage} \\ E & = & \text{Voltage} \end{array}$$

**Examples:**

A 2 HP (1 ph) unit operating at 230 Volts has an amperage draw of 11.7 amps.  
What is the Kva rating?

$$Kva(1 \text{ ph}) = \frac{11.7 \times 230}{1000} = 2.69 \text{ Kva}$$

A 5 HP(3 ph) unit operates at 460 volts and has an amperage draw of 8.0 amps.  
What is the kilowatt rating?

$$Kva(3 \text{ ph}) = \frac{8.0 \times 460 \times 1.73}{1000} = 6.37 \text{ Kva}$$

# Kilowatt and Kva Ratings for Aerators with Franklin Motors

HP Rating	Voltage Phase & Hz	*Running Amperage	Power Factor	Kilowatt Rating	Kva Rating
1/6	115 1 ph. 60Hz.	1.8	.94	.19	.21
1/6	208 1 ph. 60Hz	1.1	.94	.21	.23
1/6	230 1 ph. 60Hz	1.0	.94	.19	.22
1/6	220 1 ph. 50Hz	1.0	.94	.19	.22
1/2	115 1 ph. 60Hz	12.0	.58	.37	1.38
1/2	230 1 ph. 60Hz	6.0	.58	.37	1.38
1/2	220 1 ph. 50Hz	3.9	.58	.37	.86
3/4	230 1 ph. 60Hz	8.0	.62	.55	1.84
1	115 1 ph. 60Hz	13.4	.74	1.14	1.54
1	208 1 ph. 60Hz	7.4	.74	1.14	1.54
1	230 1 ph. 60Hz	6.7	.74	1.14	1.54
1	220 1 ph. 50Hz	7.7	.74	1.25	1.69
2	208 1 ph. 60Hz	12.9	.76	2.04	2.68
2	230 1 ph. 60Hz	11.7	.76	2.05	2.69
2	220 1 ph. 50Hz	12.4	.76	2.09	2.75
3	208 1 ph. 60Hz	14.1	.85	2.49	2.93
3	230 1 ph. 60Hz	12.8	.85	2.50	2.94
3	220 1 ph. 50Hz	14.9	.85	2.78	3.27
3	208 3 ph. 60Hz	9.4	.87	2.94	3.38
3	230 3 ph. 60Hz	8.5	.87	2.94	3.38
3	460 3 ph. 60Hz	4.3	.87	2.98	3.42
3	380 3 ph. 50Hz	4.6	.87	2.63	3.02
5	208 3 ph. 60Hz	15.4	.84	4.65	5.54
5	230 3 ph. 60Hz	14.0	.84	4.68	5.57
5	460 3 ph. 60Hz	8.0	.84	4.68	5.57
5	380 3 ph. 50Hz	6.5	.84	3.58	4.27
10**	208 3 ph. 60Hz	26.4	.91	8.64	9.50
10**	230 3 ph. 60Hz	24.0	.91	8.69	9.55
10**	460 3 ph. 60Hz	12.0	.91	8.69	9.55
10**	380 3 ph. 50Hz	15.5	.91	9.27	10.18

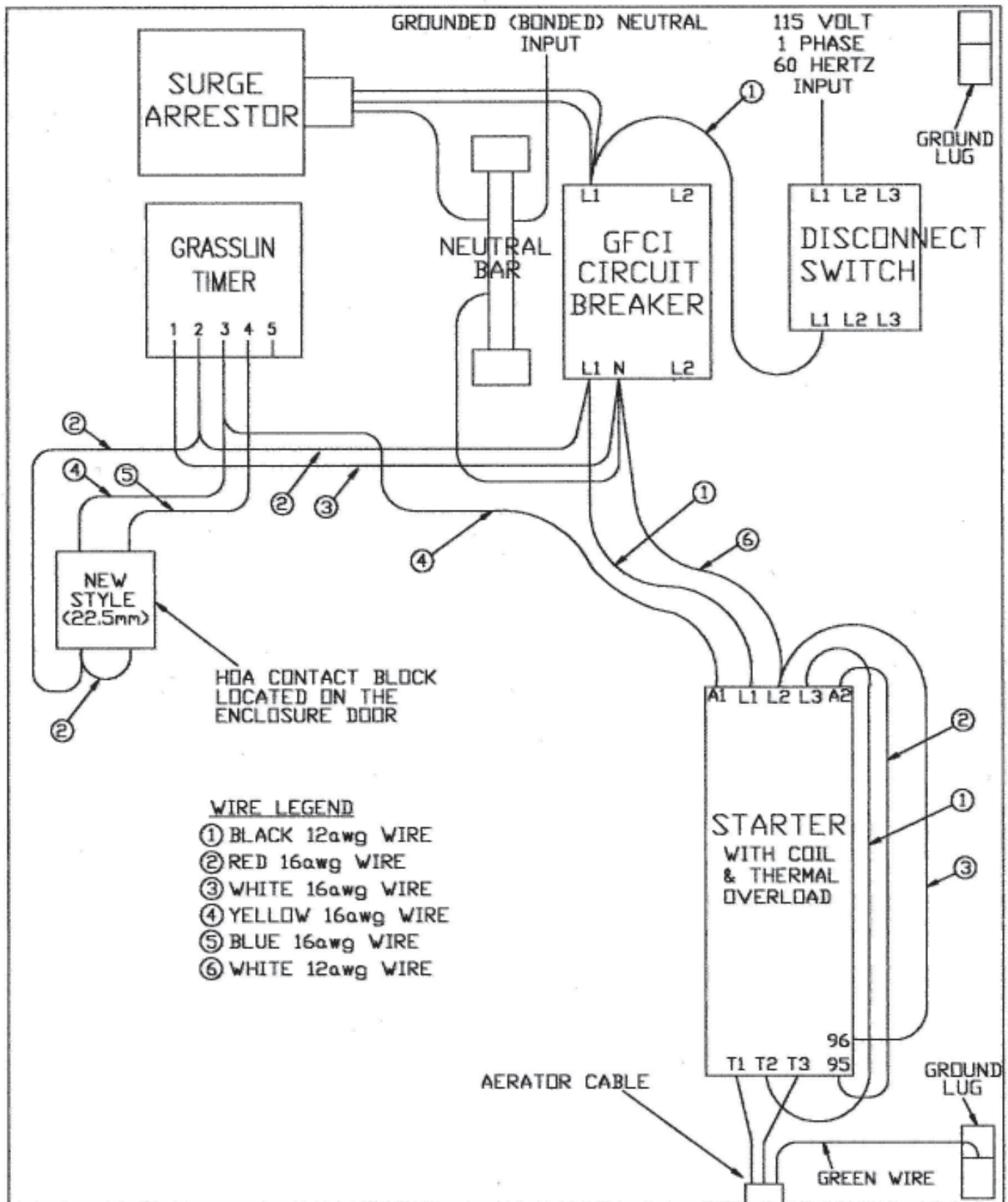
\*Running amperage listed is an average. Actual amperage may vary due to model, age, and cable size and length.

\*\* 10 HP is a Leeson or Magnetek motor.



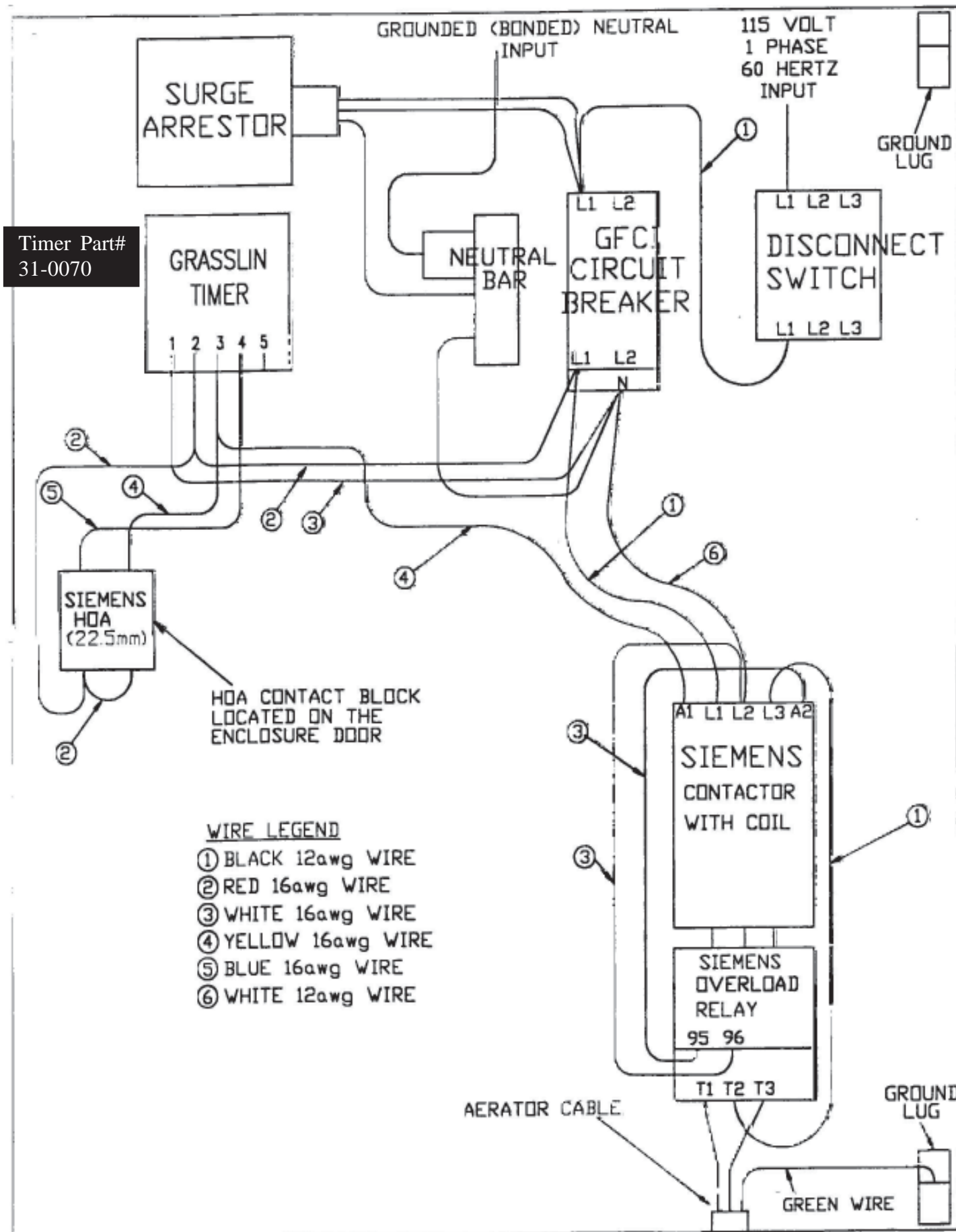
# CONCEPT 2/CONCEPT 3

115V, Single Phase, 60 Hz Panel Wiring (with Old Cutler-Hammer Contactor)



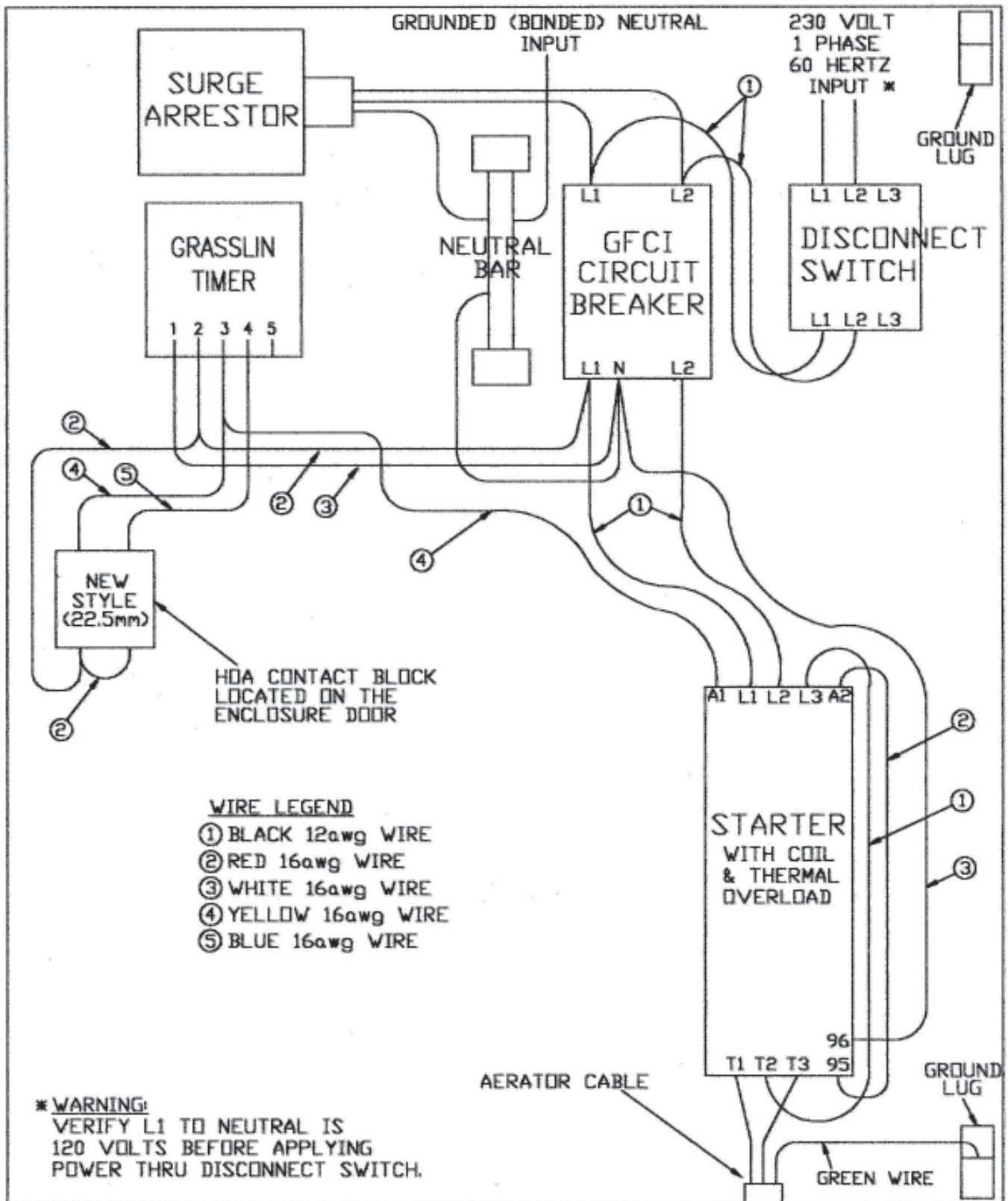
# CONCEPT 2/CONCEPT 3

115V, Single Phase, 60 Hz Panel Wiring (with Siemens Contactor)



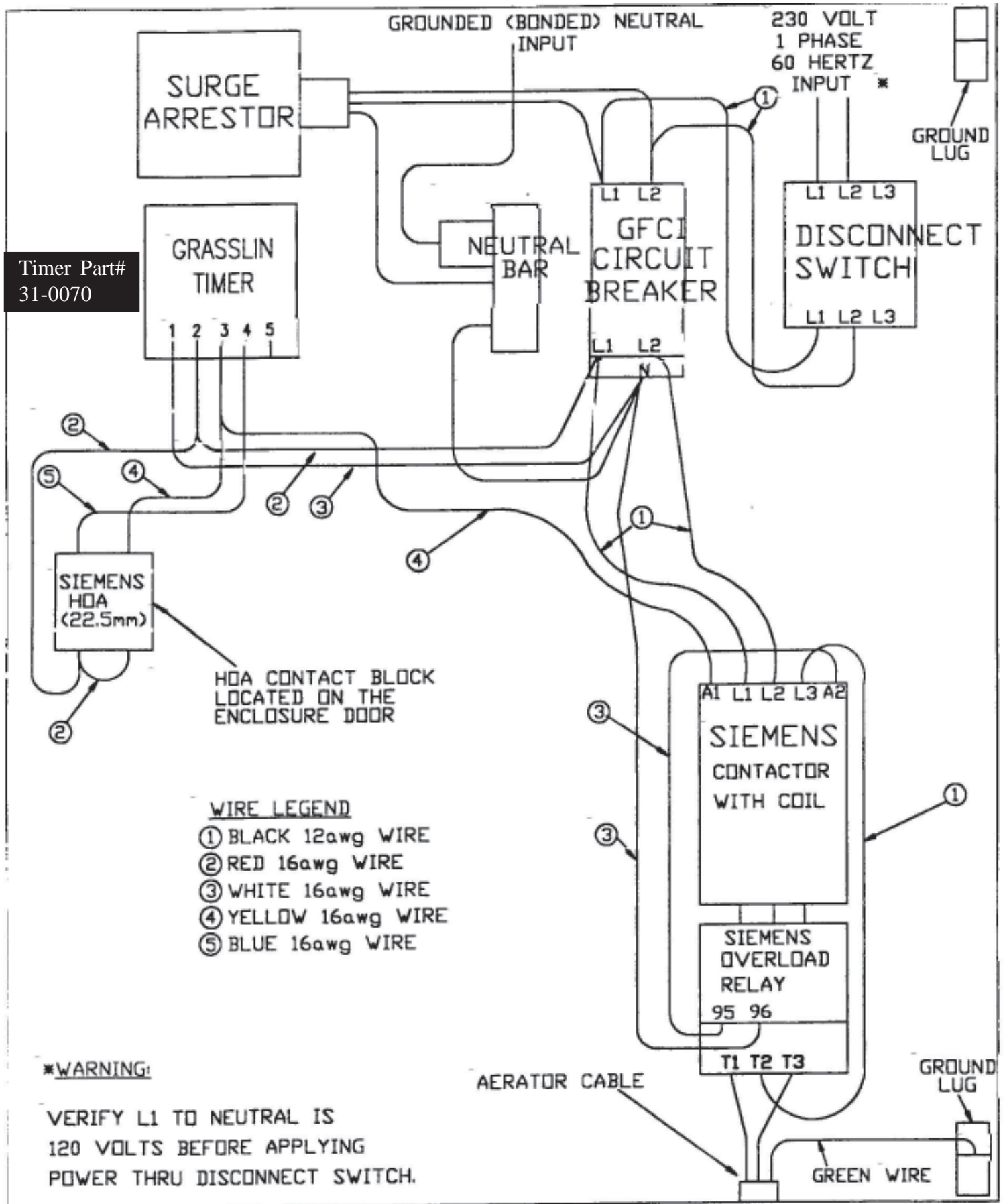
# CONCEPT 2/CONCEPT 3

230V, Single Phase, 60 Hz Panel Wiring (with Old Cutler-Hammer Contactor)



# CONCEPT 2/CONCEPT 3

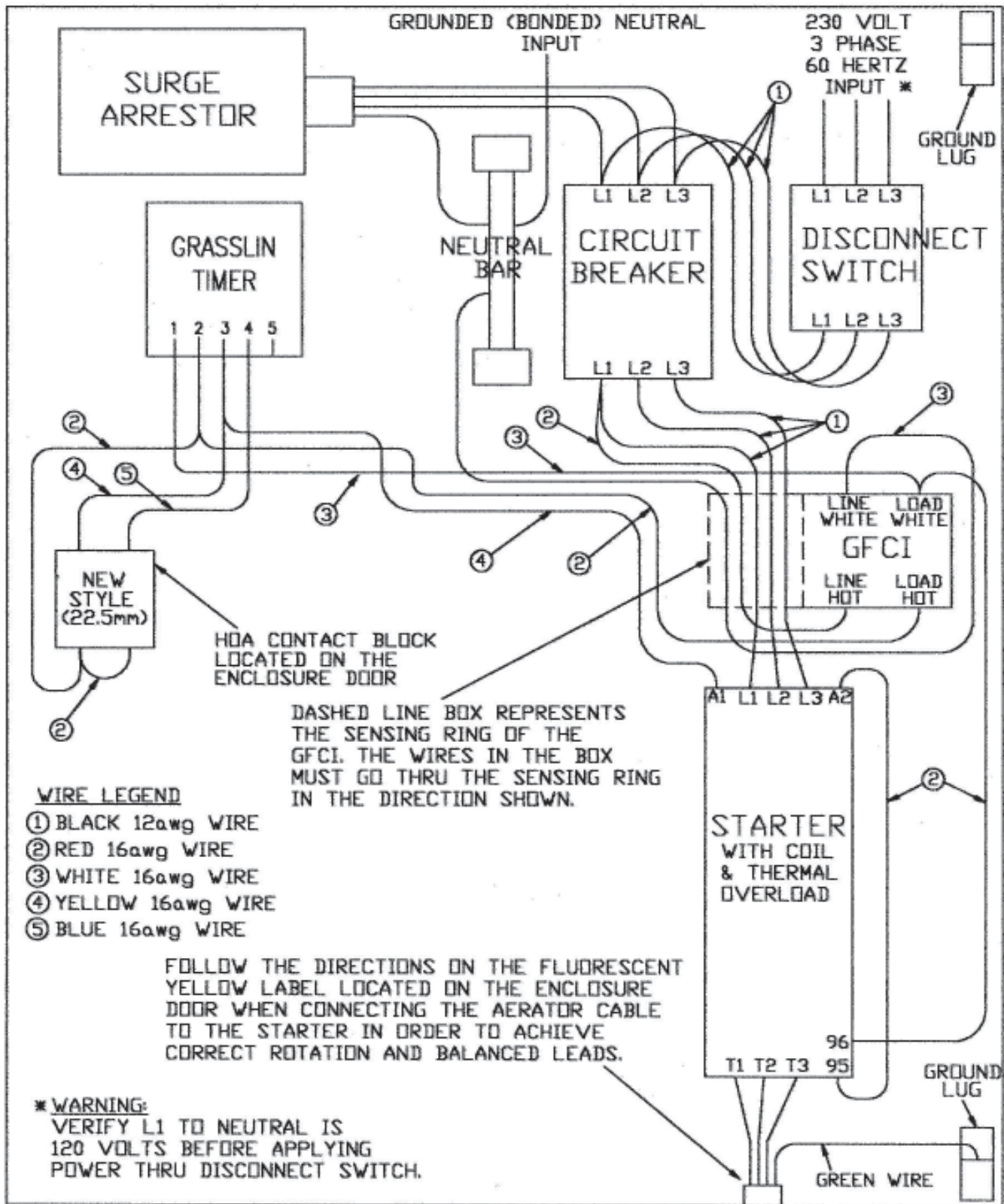
230V, Single Phase, 60 Hz Panel Wiring (with Siemens Contactor)





# CONCEPT 2/CONCEPT 3

230V, Three Phase, 60 Hz Panel Wiring (with Old Cutler-Hammer Contactor)

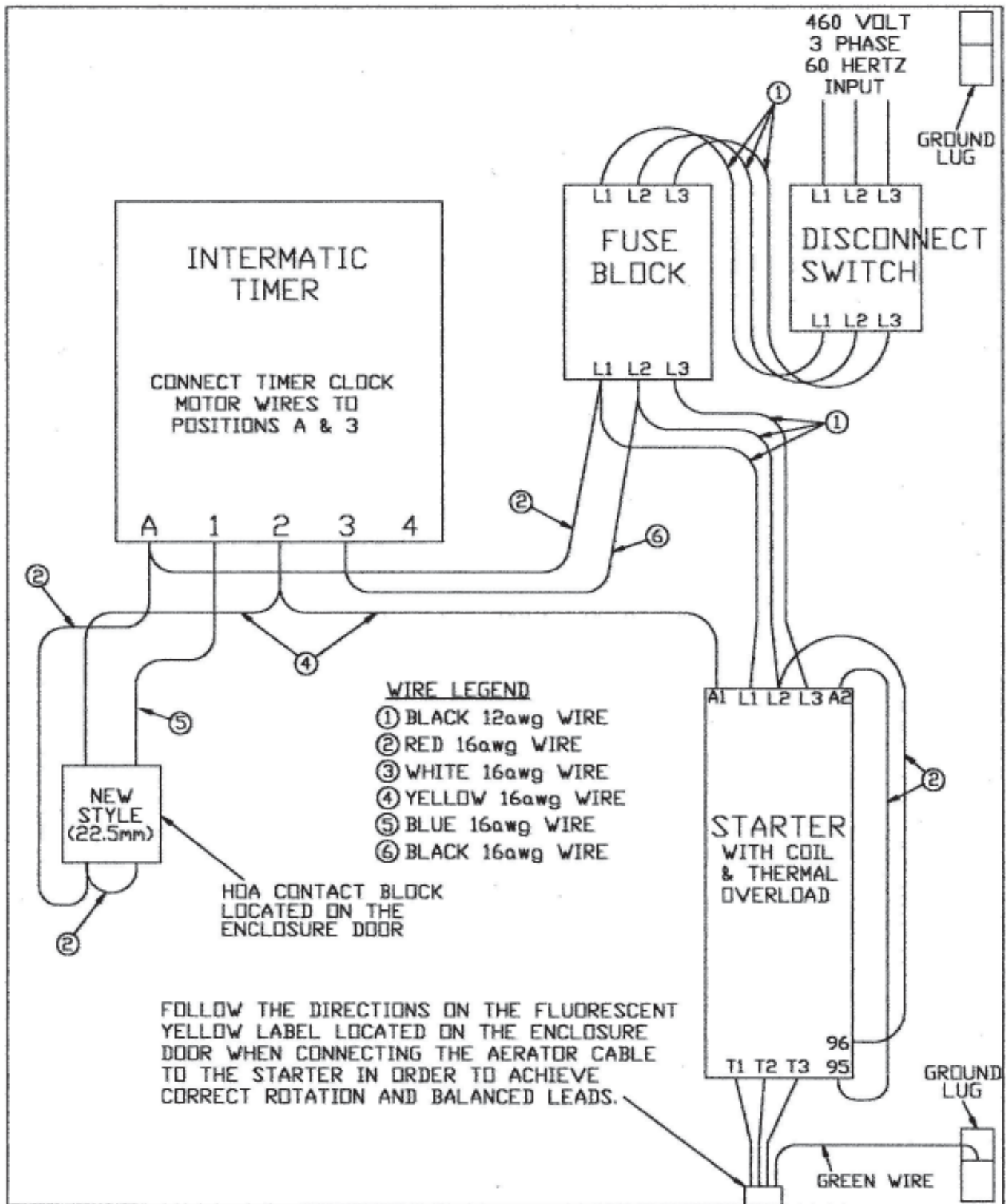


## 230V, Three Phase, 60 Hz Panel Wiring (with Siemens Contactor)



# CONCEPT 2/CONCEPT 3

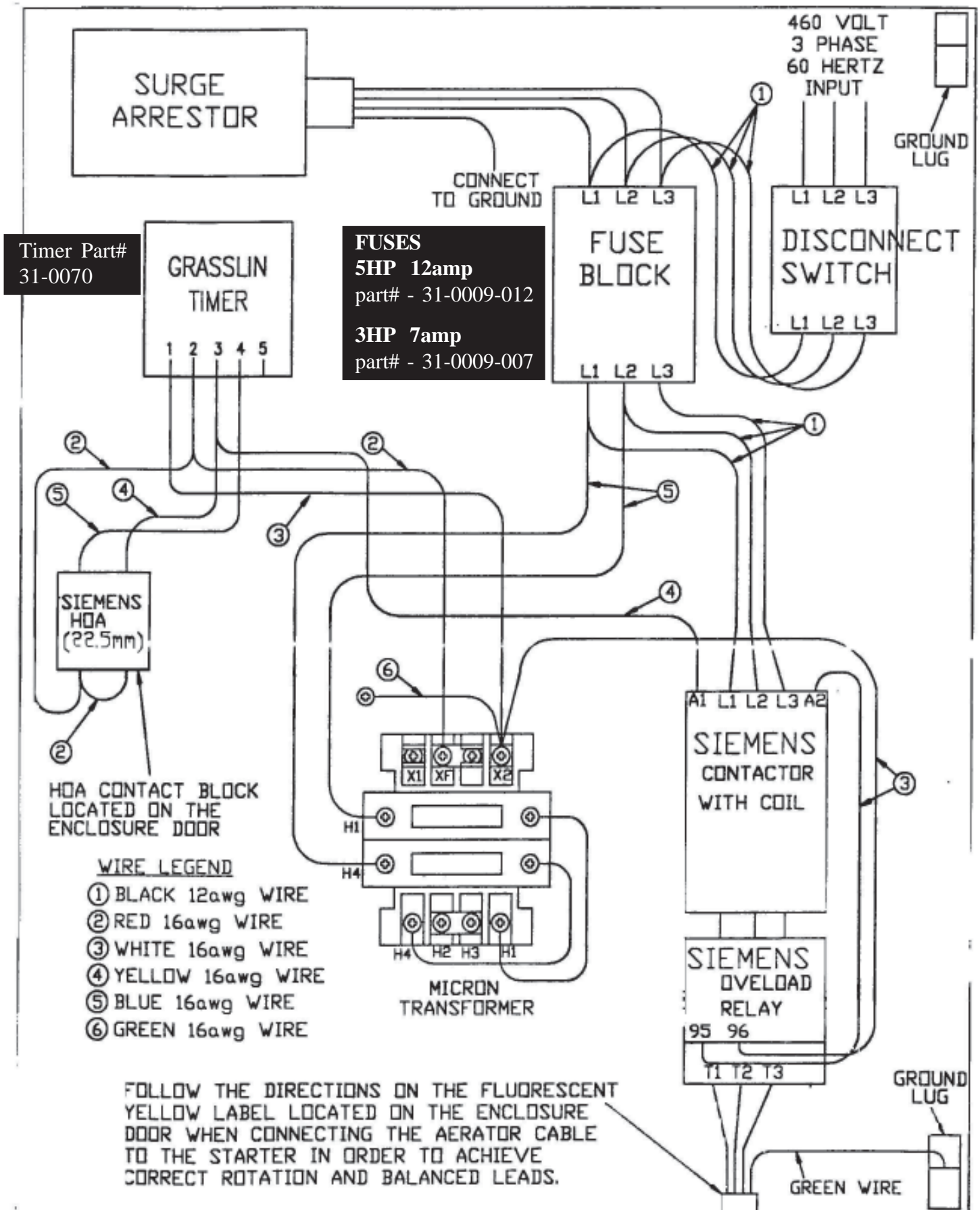
460V, Three Phase, 60 Hz Panel Wiring (with Old Cutler-Hammer Contactor)





# CONCEPT 2/CONCEPT 3

460V, Three Phase, 60 Hz Panel Wiring (with Siemens Contactor)





For 3/4 hp Motor: 15 A Fuse



- ① BLACK 12awg WIRE
- ② RED 12awg WIRE
- ③ RED 16awg WIRE
- ④ WHITE 16awg WIRE

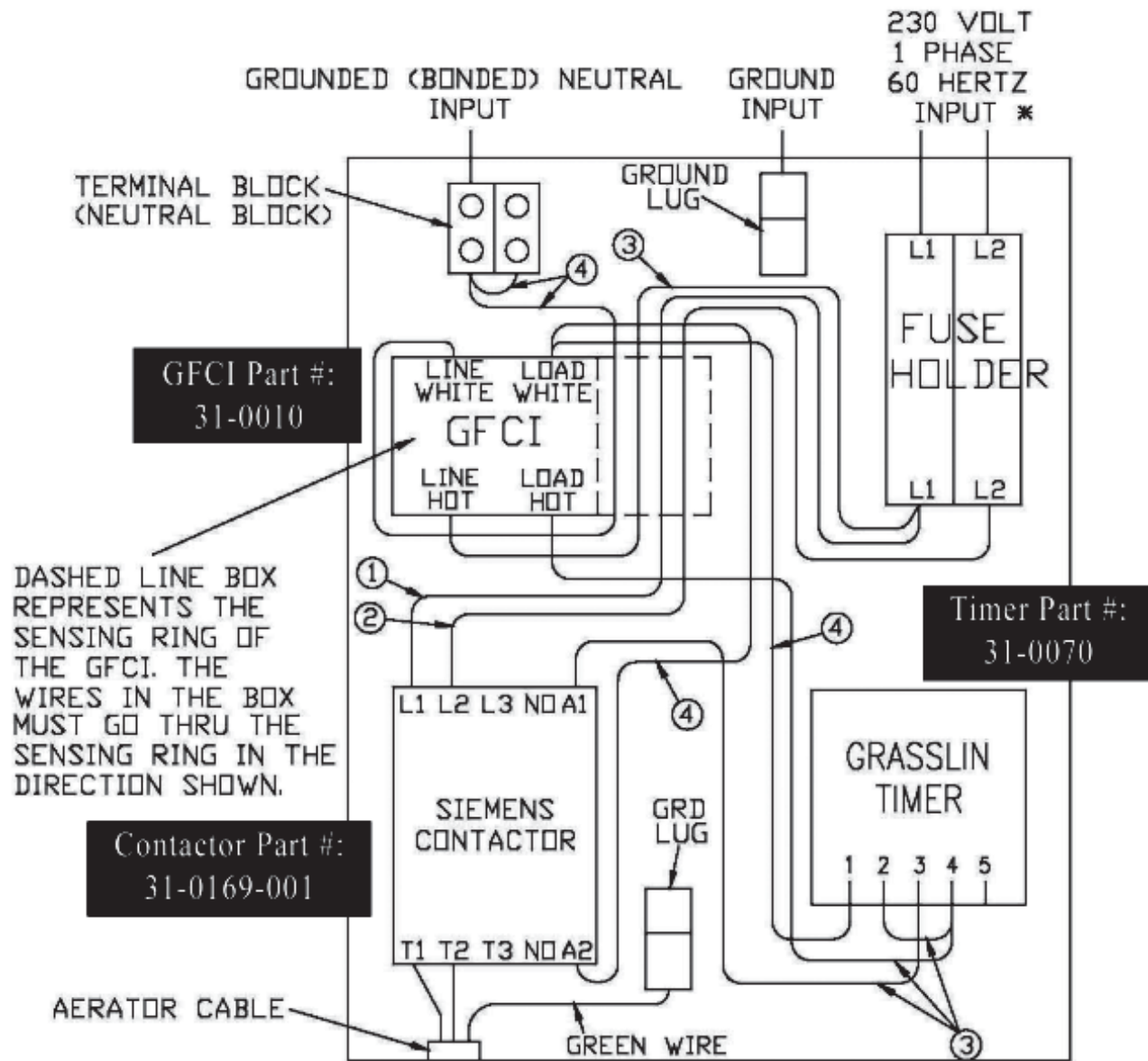
\* WARNING:

VERIFY L1 TO NEUTRAL IS  
120 VOLTS BEFORE APPLYING  
POWER THRU DISCONNECT SWITCH.

# INSTANT FOUNTAIN CONTROL PANEL WIRING

For 1/2 HP Motor: 10 A Fuse

For 3/4 hp Motor: 15 A Fuse



## WIRE LEGEND

- ① BLACK 12awg WIRE
- ② RED 12awg WIRE
- ③ RED 16awg WIRE
- ④ WHITE 16awg WIRE

## \*WARNING:

VERIFY L1 TO NEUTRAL IS  
120 VOLTS BEFORE APPLYING  
POWER THRU DISCONNECT SWITCH.

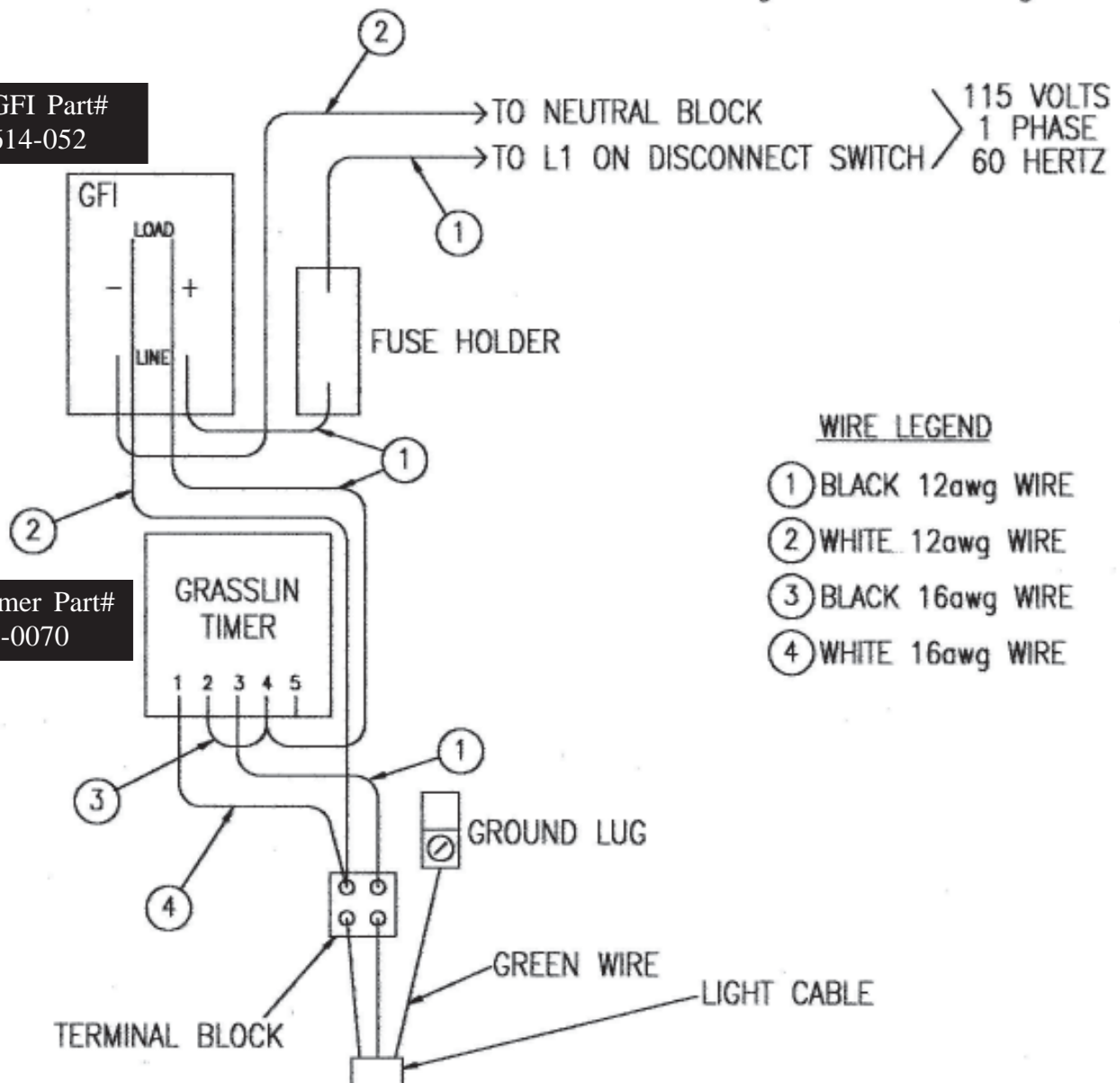
# HIGH VOLTAGE & HIGH INTENSITY LIGHT CONTROL WIRING

For High Intensity Lights: 3.2 A Fuse

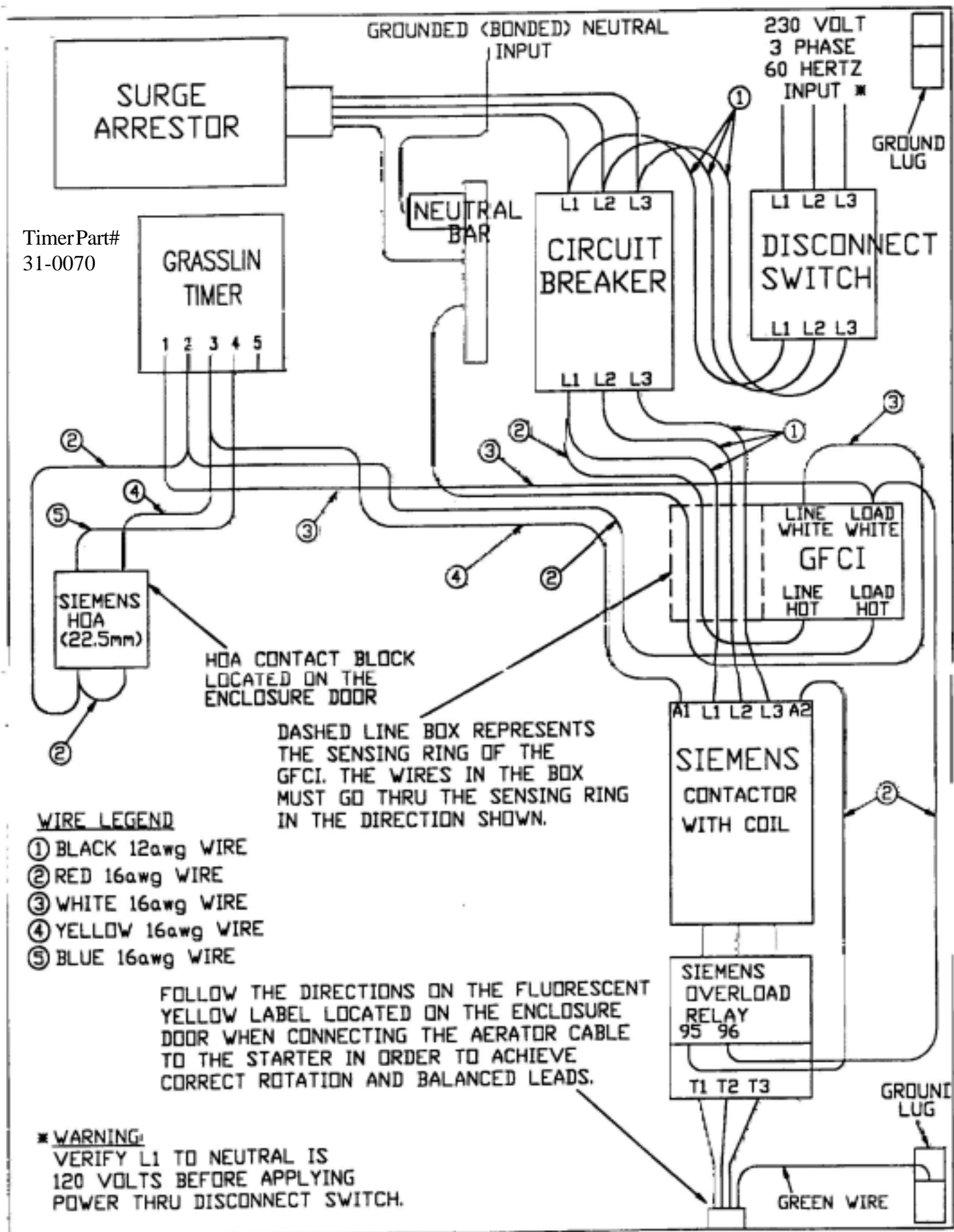
For High Voltage Lights: 10 A Fuse for 2,3,4 250W Lights & 2 500W Lights

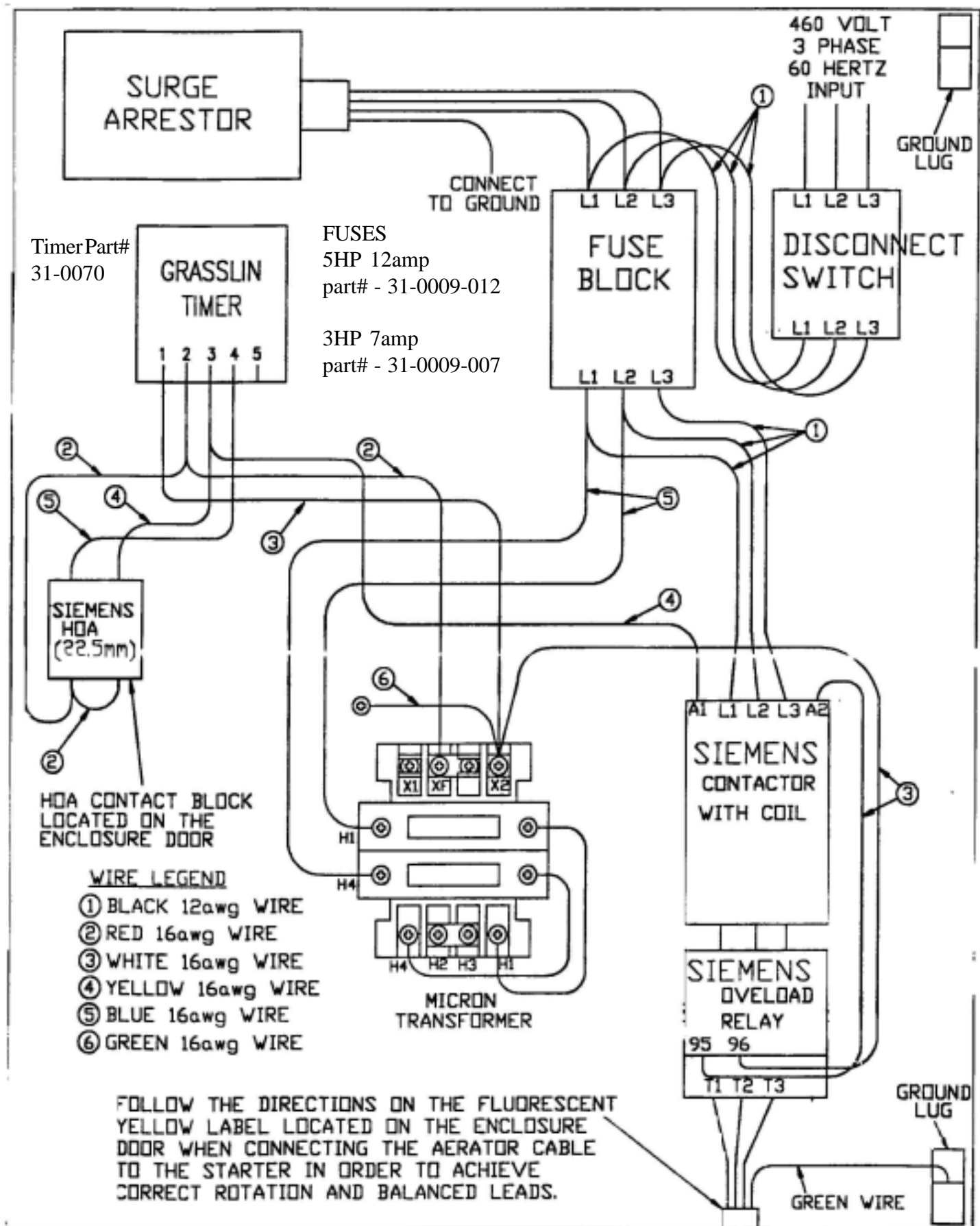
15 A Fuse for 5 250W Lights & 3 500W Lights

GFI Part#  
614-052

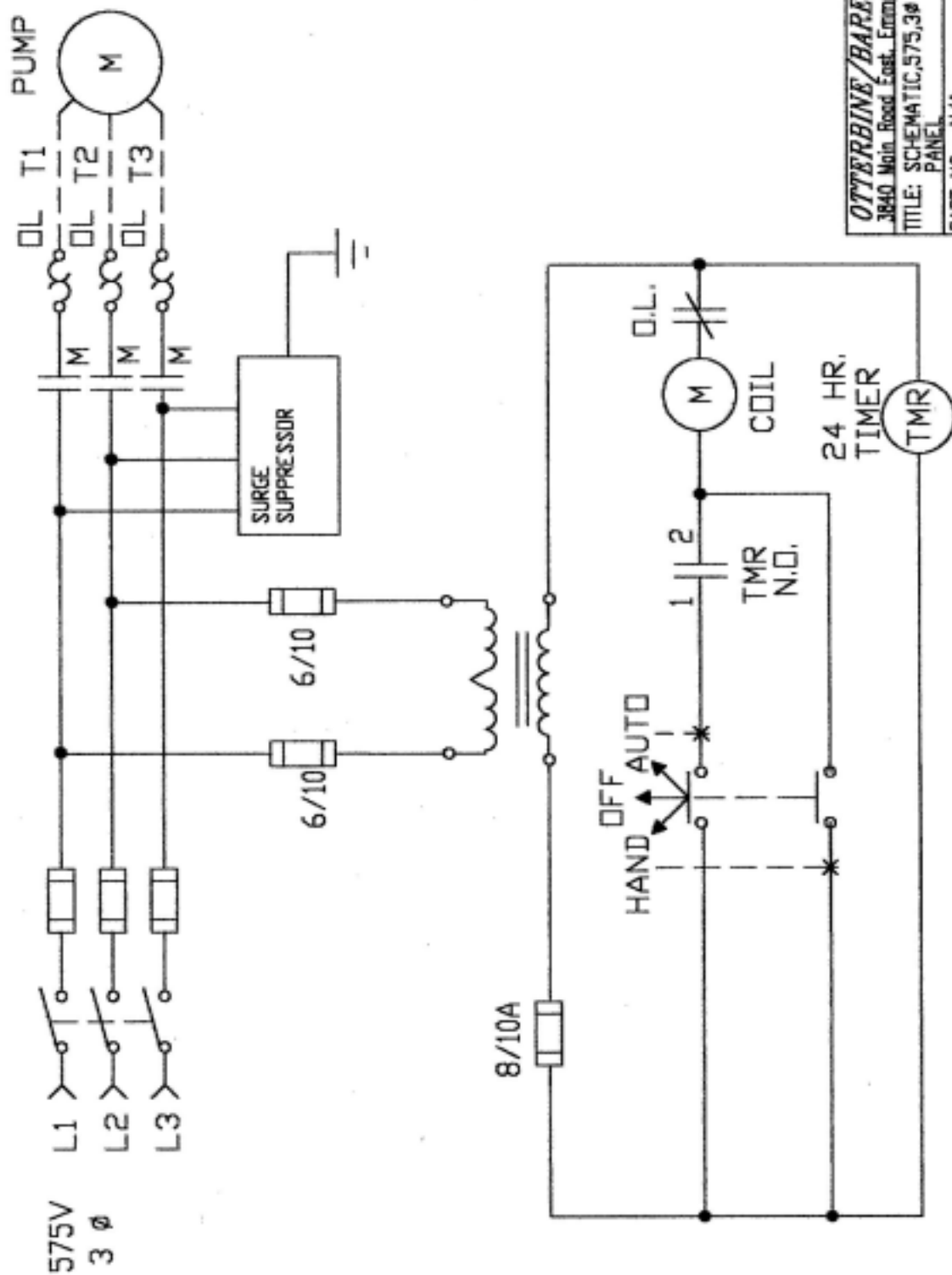


Timer Part#  
31-0070

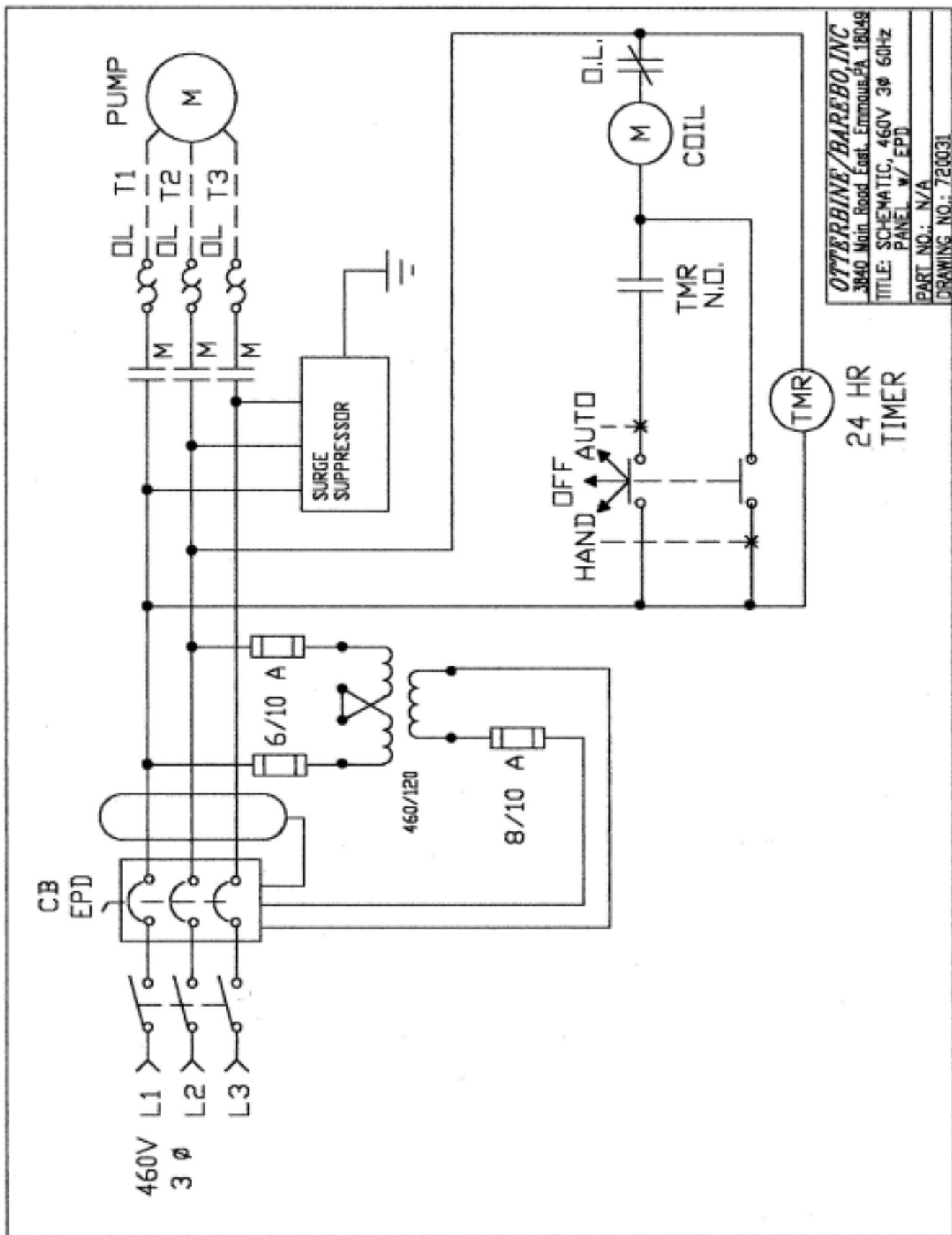




REV	ERN/ECN	BY	DATE	CHKD	BY	DATE
1	A	RELEASE	REH 06-30-93			

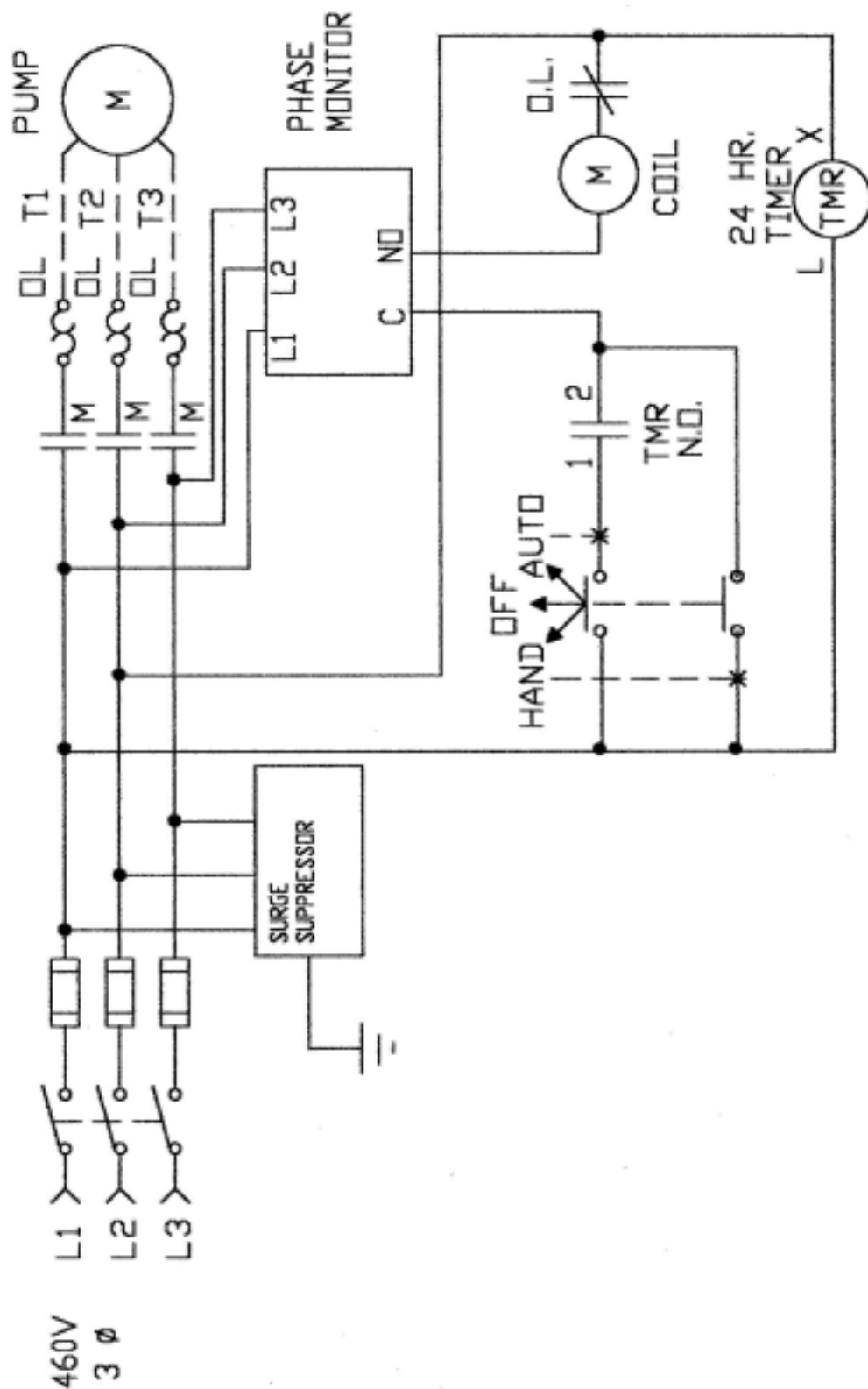


OTTERBINE/BAREBO, INC.  
3840 Main Road East, Ermaus, PA 16048  
TITLE: SCHEMATIC, 575, 3Ø  
PANEL  
PART NO.: N/A  
DRAWING NO.: 720016





REV/ERN/ECN	BY/DATE	CKD BY/DATE
A	RELEASE RH050596	TW050796

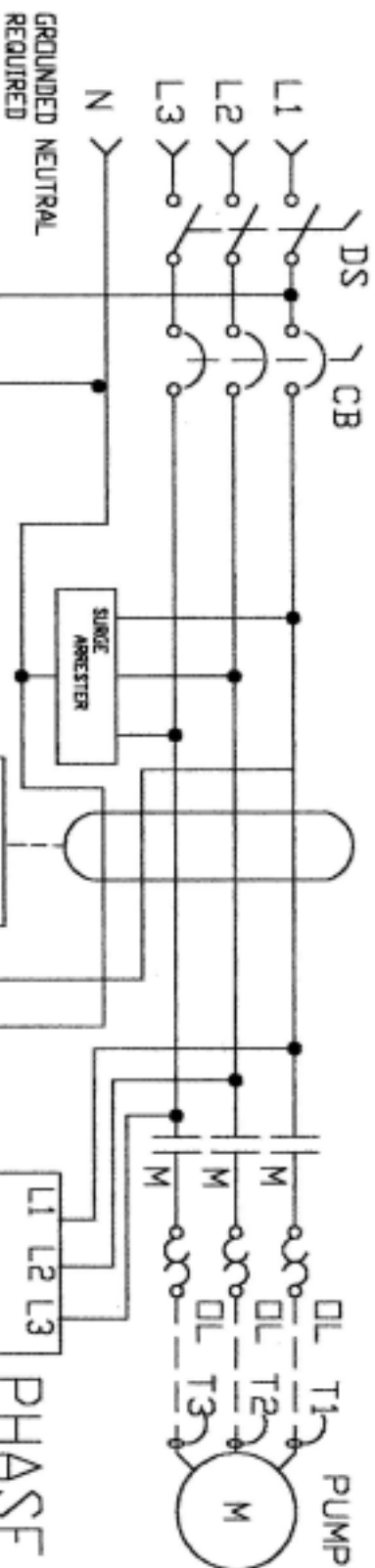


<b>OTTERBINE/BAREBO, INC</b>
3840 Main Road East, Emmaus, PA 18049
TITLE: SCHEMATIC, 460, 3Ø
PANEL, WITH PHASE MONITOR
PART NO.: N/A
DRAWING NO.: 720253

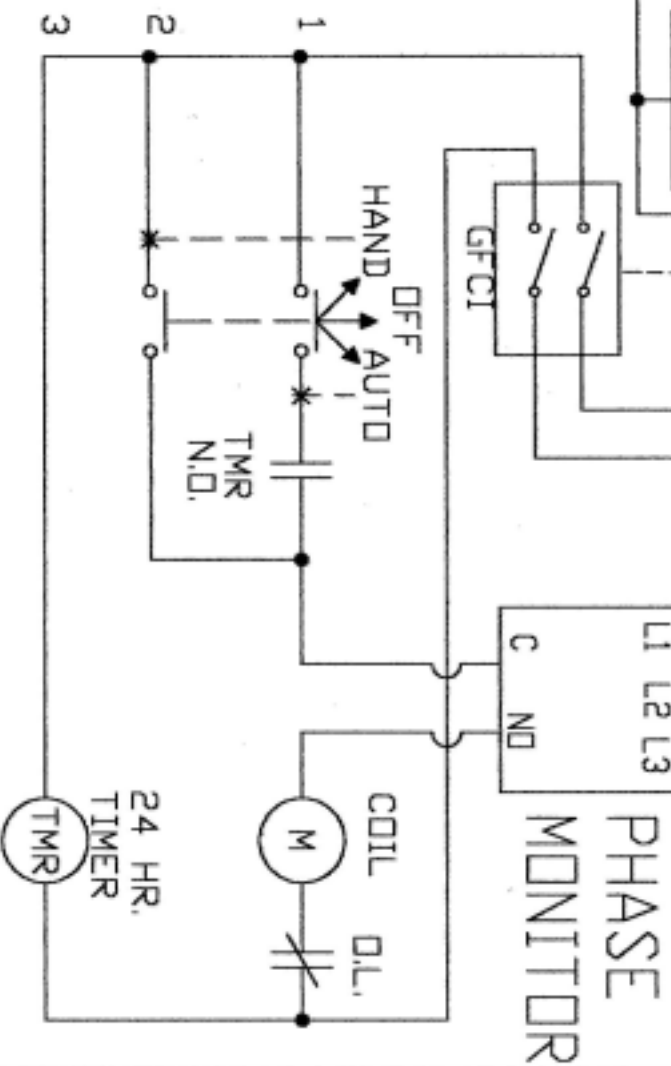


# CUTLER HAMMER 3 PHASE

REV	ERN/ECN	BY/DATE	CKD BY/DATE
1	N/A	REH 12/17/93	TWD 12/22/93



TO LIGHT OPTION  
IF INSTALLED  
(SEE PAGE 2)

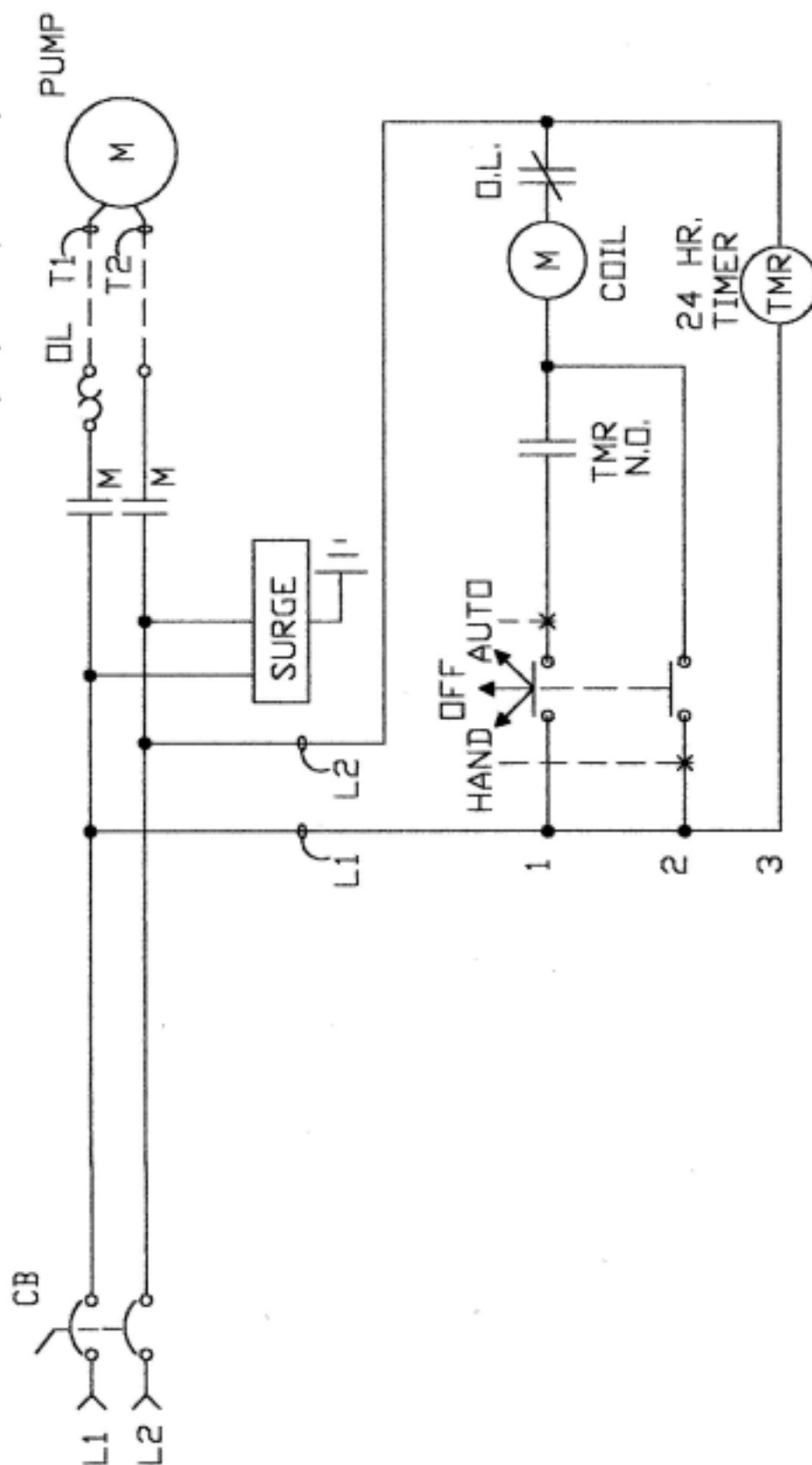


**OTTERBINE/BAREBO, INC**  
3840 Main Road East, Emmaus, PA 18049  
TITLE: CUTLER HAMMER PCC 230V  
3PH 60HZ, V/PHASE MONITOR  
PART NO.: N/A  
DRAWING NO.: 720252

3 PHASE 208/230V 60HZ

## WESTINGHOUSE 1 PHASE

REV/ERN/ECN	BY/DATE	CKD BY/DATE
A	RELEASE REH 041293	TWD 041593

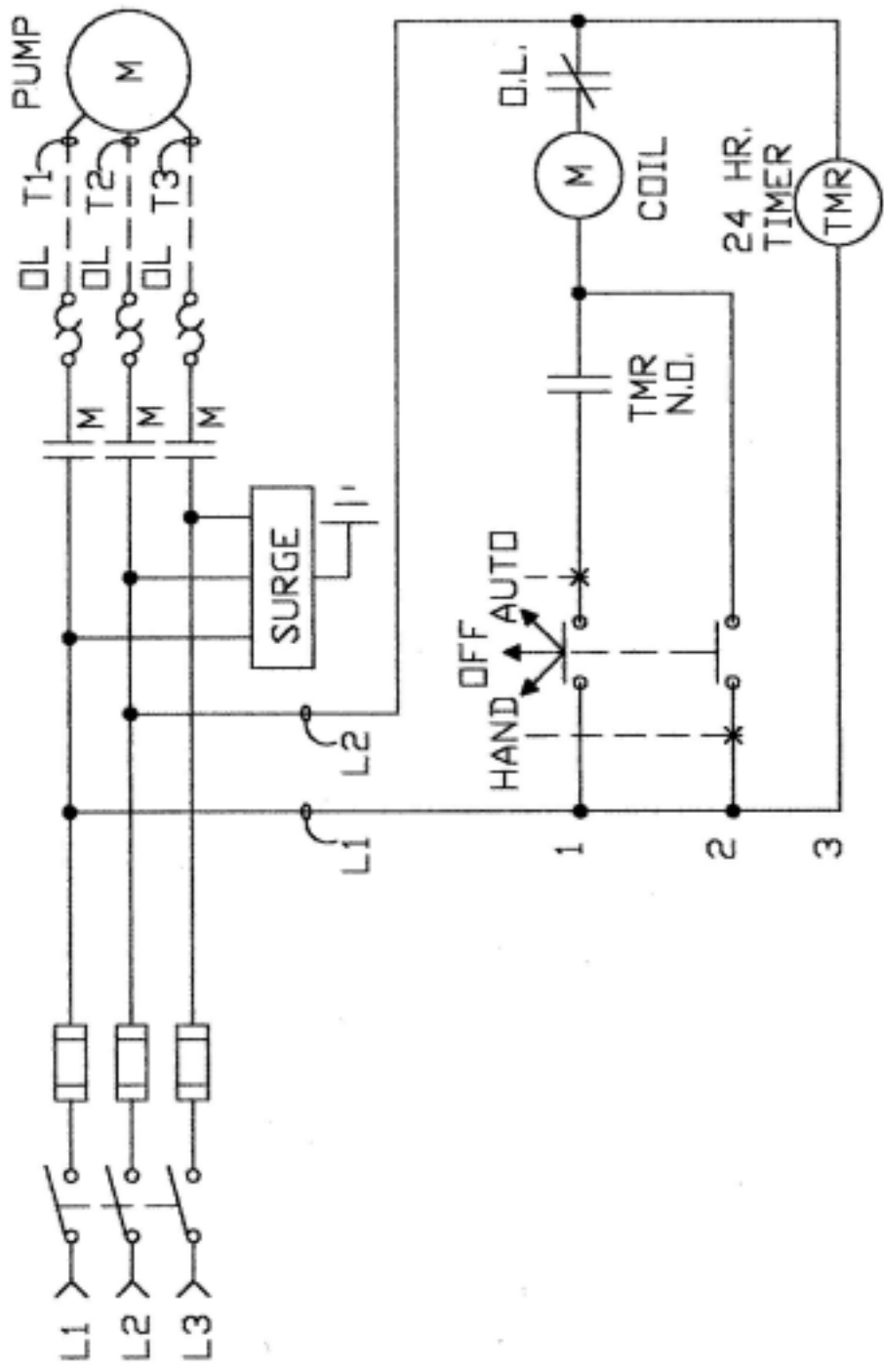


GFI OPTION FOR PUMP  
NOT ILLUSTRATED

OTTERBINE/BAREBO, INC  
3840 Main Road East, Emmaus, PA 18049  
TITLE: WESTINGHOUSE 1 PH  
PCC  
PART NO.: N/A  
DRAWING NO.: 720056

REV	ERN/ECN	BY	DATE	CKD	BY	DATE
A		RELEASE	REH 041293	TWD	041593	

# WESTINGHOUSE 3 PHASE



GFI OPTION FOR PUMP  
NOT ILLUSTRATED

<b>OTTERBINE/BAREBO INC</b>	
3840 Main Road East, Emmaus, PA 18049	
TITLE: WESTINGHOUSE PCC 3PH	
208/230V 60HZ	
PART NO.: N/A	
DRAWING NO.: 720057	

## Installation of Units with GFCI

Ground Fault Circuit Interrupter (GFCI) is standard on all 60Hz single and on 60Hz 208/230V three phase systems. GFCI is optional on all other units. To properly install the system and prevent "nuisance" tripping of the GFCI device, please make note of the following recommendations:

- A) Use only Otterbine cable between the power control panel (PCC) and the aerator.
- B) Try to install the unit and PCC with the shortest possible cable between the two.
- C) If between the PCC and the aerator, a junction box or underground conduit is used with individual conductors:
  - 1) Place the aerator cable in it's own conduit. Run the lite cable through a different conduit.
  - 2) Do not run multiple aerators conductors/cables through the same conduit.
  - 3) Verify the wire used is properly rated.
- D) If splicing is required, follow the instructions carefully to verify a waterproof seal.
- E) Make sure to apply the dielectric compound to the bulkhead/pigtail connection.
- F) If the bulkhead/pigtail connectors are wet, dry the connectors with a clean dry cloth and apply dielectric compound before connecting.

Please note that periodically a GFCI device will trip due to lightning or brown/blackouts. However, if the GFCI trips and continues to trip after being reset, it is signaling that there is a fault in the electrical circuit. If this occurs, the installation must be corrected by a qualified electrician.